Topaz S3 Inverters 0.5 kVA, 1 kVA, and 2 kVA Owner's Manual

MGE
UPS SYSTEMS

IMPORTANT SAFETY INSTRUCTION

SAVE THESE INSTRUCTIONS — This manual contains important instructions for all inverters that must be followed during installation, operation and maintenance of the equipment.

WARNING

To reduce the risk of fire or electric shock, install in a temperature and humidity controlled indoor area free of conductive contaminants.

ATTENTION

Pour réduire le riske d'inccendie ou d'électrocution, installer dans une enciente intérieure contrôlée en température et humidité et sans contaminants conducteurs.

WARNUNG!

Um die Gefahr von Feuer und elektrischem Schock zu reduzieren, muss das Geraet in einem temperatur - und feuchtigkeitskontrolliertem Raum, frei von leitungsfaehigen Verunreinigungen, installiert werden..

WARNING

Opening enclosures expose hazardous voltages. Always refer service to qualified personnel only.

ATTENTION

L'ouverture des cabinets expose des tensions dangereuses. Assurez-vous toujours que le service ne soit fait que par des personnes qualifiees.

WARNUNG!

Offene Raeume entladen gefaehrliche Stromspannungen. Bitte wenden sie sich an qualifiziertes Dienstpersonal.

WARNING

As standards, specifications, and designs are subject to change, please ask for confirmation of the information given in this publication.

ATTENTION

Comme les normes, spécifications et produits peuvent changer, veuillez demander confirmation des informations contenues dans cette publication.

WARNUNG!

Normen, Spezifizierungen und Plaene unterliegen Aenderungen. Bitte beantragen Sie schriftliche Bestaetigung ueber Informationen die in dieser Herausgabe gemacht wurden.

NOTE

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

This manual covers these models:

PRODUCTS	*MODEL*	*RATING*
Topaz S3 Inverters	*63054*	*500 VA*
	63104	*1000 VA*
	63204	*2000 VA*

Topaz S3 Inverters 0.5KVA, 1 kVA, AND 2kVA Owner's Manual

For service call
1-800-523-0142

86-153061-00 B03 3/99

MGE UPS Systems, Inc.
1660 Scenic Avenue
Costa Mesa, CA 92626
(714) 557-1636

MGE UPS SYSTEMS

Topaz S3 Inverters 0.5 kVA,1 kVA, & 2kVA Owner's Manual

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MGE UPS Systems warranty: warranties to distributors and other commercial customers: MGE UPS Systems warrants equipment manufactured by MGE UPS Systems to be free from defects in materials and workmanship for a period of one year from date of installation, but no longer than eighteen months from purchase by end user. No warranty shall extend more than three years beyond date of manufacture, except for Ultra-Isolator® Noise Suppressors which carry a five-year warranty. If within such period purchaser discovers such item was not as warranted above and promptly notifies the company in writing, MGE UPS Systems shall repair or replace the item at the Company's option.

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Direct questions about the operation, repair, or servicing of this equipment to MGE UPS Systems Customer Support Services. Include the part number, assembly number, and serial number of the unit in any correspondence. Should you require factory service for your equipment, contact MGE UPS Systems Customer Support Services and obtain a Return Goods Authorization (RGA) prior to shipping your unit. Never ship equipment to MGE UPS Systems without first obtaining an RGA.

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Revision History

Topaz S3 Inverters 0.5 kVA, 1 kVA, and 2 kVA Owner's Manual
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Contents

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Section II — Installation and Operation

Section III — Theory of Operation

Section IV— Maintenance and Service

Illustrations

Tables

How To Use This Manual:

This manual is designed for ease of use and easy location of information.

To quickly find the meaning of terms used within the text, look to the Glossary.

The paragraph symbol (¶) indicates numbered paragraphs that can be quickly found in the Contents on page iii.

This manual uses Noteboxes to convey important information.

Noteboxes come in four varieties:

WARNING

A WARNING notebox indicates information provided to protect the user and service personnel against safety hazards and/or possible equipment damage.

CAUTION

A CAUTION notebox indicates information provided to protect the user and service personnel against possible equipment damage.

IMPORTANT

An IMPORTANT notebox indicates information provided as an operating instruction, or as an operating tip.

NOTE

A NOTE notebox indicates information provided as an operating tip or an equipment feature.

Introduction

WARNING

An AC output will be present at the output terminals immediately when AC input is energized even without the inverter module installed in the receiver cabinet.

ATTENTION

La tension alternative de sortie appara ît dès la mise sous tension de le'entrée, même si le module onduleur n'est pas installé.

WARNUNG

Die Netzausgangsspannung ist unmittelbar an den Ausgangsklemmen, sowie der Netzeingang angeschlossen wird-slebst wenn der Einschub nicht im Gestell ist.

1.0 Scope

This manual provides technical information required for installation, operation and maintenance of the Topaz S3 inverters with power ratings of 0.5 kVA, 1.0 kVA, and 2kVA. Please read this manual before operating the Topaz S3 equipment. Please retain this manual for future reference.

The manual is divided into four sections:

Section I — Introduction
This section introduces the Topaz S3 family of single phase inverters, including a general description of the system and its internal components, a description of available options, and system specifications.

Section II — Installation and Operation
This section presents installation and operating information for Topaz S3 inverters, including an overview of the system, its components, and their function; a description of the indicators and controls and their function; and operational sequences to be followed for all conditions of normal, emergency, and maintenance operation.

Section III — Theory of Operation
This section contains the elementary block diagram of the Inverter Module and Receiver Cabinet and a brief description of the operation of the electronics of each block.

Section IV — Maintenance and Service
This section describes maintenance of the Topaz S3 inverter, including safety instructions, preventive maintenance, and information about replacement parts, and customer service.

A Glossary in the rear of this manual provides definitions of terms used within the text.

1.1 General Description

The sine wave inverter provides stable, distortion-free AC power from a DC input source, at a selectable output voltage and frequency, for sensitive equipment which must be operated in locations where commercial AC power is not available. With a static switch option, the inverter also forms a reliable and economical part of uninterruptible power systems in either on-line or off-line mode. See Section III, Theory of Operation, for detailed information on inverter characteristics.

This model is designed for rack mounting in 19 inch, 23 inch, or 25 inch racks and either flush front panel or center mountable, depending on the position and location of the mounting flanges.

1.2 Options

Check the model dash number of your unit to make sure it is the type you need. Standard options are as follows:

Description	Product Numbers	
	500VA & 1kVA	**2kVA**
Topaz S3 Inverter with Status indicators.	63054-92, 63104-92	63204-92
Topaz S3 Inverter with Status indicators, Digital LCD, and Static Transfer Switch.	63054-94, 63104-94	63204-94
Receptacles:		
(4) NEMA 5-15R	6310-R91	6320-R91
(4) IEC-320	6310-R92	6320-R92
Support Bracket Kit (Recommended when using forward mounted brackets) for 19" Rack unit:		
Bracket for 23"/25" rack mount: LCD display meter with static switch Communication interface Spare kit (63204-94-SK1)	6310B-N4	6320B-N4

1.3 Specifications

Specifications subject to revision without notice.

1.4 Characteristics of Model

Table 1- 1 : Characteristics of Inverter

Model Number	Output Power Rating (VA/Watts)	Nominal Input Voltage (Vdc)**	Input Voltage Range (Vdc)	Max. Input DC Current Amperes	Nominal Output AC Amperes at Selectable Output Voltage of: 120V	220V	230V	240V
63204*	2000/1680	-48	42 to 57	60	16.6	8.4	8.4	8.4
63104*	1000/840	-48	40 to 60	30	8.3	4.2	4.2	4.2
63054*	500/420	-48	40 to 60	16	4.2	2.1	2.1	2.1

*Model number is followed by a two-digit dash number:

-92 = Inverter with Status indicators.

-94 = Inverter with Status indicators, Digital LCD, and Static Transfer Switch.

**DC voltage rating is given with respect to earth or chassis ground.

1.5 Electrical Specifications

1.5.1 Surge Withstand Capability

0.5 microsecond, 100 kHz ringing wave with 6000V peak, with no resulting damage per IEEE587.

1.5.2 DC Input Conducted Emission

Less than 30 dBrnC.

1.5.3 Efficiency

80% minimum (on-line mode).

97% typical (off-line mode).

1.5.4	**Harmonic Distortion**	Does not exceed 3% for all linear and non-linear (computer) load conditions within the VA/Watt rating.
1.5.5	**Line Regulation**	Inverter output RMS voltage will vary 1% maximum for line variations between low line and high line at any load between no load to rated load.
1.5.6	**Load Regulation**	Inverter output RMS voltage will vary 1% maximum for load variations between no load and full load at nominal line.
1.5.7	**Power Factor**	2 kVA/1680 Watts, 1 kVA/840 Watts, and .5 kVA/420 Watts maximum rating available over power factor range of 0.6 leading to 0.6 lagging over rated DC input voltage range. Crest factor up to 3:1 for non-linear loads within rated VA/Watt ratings.
1.5.8	**Output Frequency**	50 or 60 Hz, user selectable (see Figure 1-3). When option -94, Static Transfer Switch is installed and utility AC is present, the output frequency will be phase locked to within +/- 6 degrees of the utility frequency. Frequency slew rate shall be less than one Hz per second. When 60 Hz is selected, the input frequency must be between 57 to 63 Hz or when 50 Hz is selected, the input frequency must be between 47 to 53 Hz or a BYPASS error will be displayed.
1.5.9	**Frequency Stability**	Free run frequency stability shall be within +/- 0.02% of the selected frequency (50Hz or 60Hz).
1.5.10	**Short Circuit Current**	300% minimum of rated load current for four to five cycles. Short circuit defined as loads greater than 220% of rated current.
1.5.11	**Overload Capability**	Continuous overload up to 125% of rated VA/watts at 40º celsius maximum (120% of rated VA/watts for 2 kVA). Moderate overload of 125% (120% for 2 kVA) to 150%, 1800 cycles (30 seconds at 60Hz). Severe overload of 150% to 220%, 24 cycles (0.4 seconds at 60Hz).
1.5.12	**Transient Deviation and Recovery**	For a 0 to 100% linear load step change, inverter output voltage will deviate no more than 20% of rated value, and shall recover within 1ms.

1.6 Indicators and Controls

See Figure 2-1 on page 2-2 for the location of indicators and controls.

1.6.1 Digital LCD (Liquid Crystal Display)

The LCD displays two lines of twenty characters. Two types of messages are displayed: system status or measurement.

A system status message is the default at turn-on, after a system failure or stop sequence.

Each line consists of three columns that identify: 1) power source, 2) source mode, 3) source status. Power source definitions are as follows: "INV." refers to the inverter module. "BYP" refers to the bypass mechanism, either maintenance bypass relay or static transfer switch.

For definitions of source mode and source status messages, as well as corresponding LED status indicator colors, refer to Table 1-2 .

Figure 1- 1 **: System Status Readout**

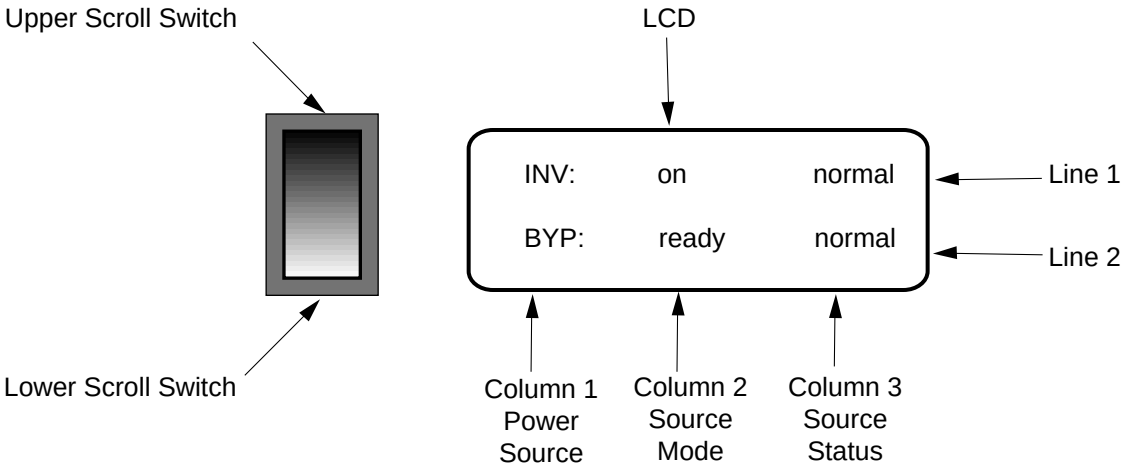


Table 1- 2 : LCD Readout Definitions

	Column 1 Power Source	Column 2 Source Mode	Column 3 Source Status	Power Source Mode / Status Definition	LED status
				SYSTEM SET TO THE ON-LINE (INVERTER) MODE.	Inverter LED
LINE 1	INV:	on	normal	System is on the inverter delivers power to the load.	Green
LINE 1	INV:	on	dc low	Input DC voltage is less than 42 volts.	Yellow
LINE 1	INV:	on	dc high	Input DC voltage greater than 57 volts.	Yellow
LINE 1	INV:	on	overload	Load greater than 125% of rated VA or Watts.** 120% for 2 kVA	Yellow
LINE 1	INV:	off	DC LOW	On Bypass. Input DC voltage less than 39.5 volts.	Red
LINE 1	INV:	off	DC HIGH	On Bypass. Input DC voltage greater than 60 volts.	Red
LINE 1	INV:	off	DC FAIL	On Bypass. Input circuit breaker turned OFF.	Red.
LINE 1	INV:	off	overload	On Bypass. Load >125%, see specification. 120% for 2 kVA	Red
LINE 1	INV:	off	software	On Bypass. Shut down, micro-processor problem.	Red
LINE 2	BYP:	ready	normal	Input AC voltage in tolerance, ready to go to bypass.	Blink Green
LINE 2	BYP:	ready	ac low	Input AC voltage less than 85% of nominal.	Blink Yellow
LINE 2	BYP:	ready	AC LOW	Input AC voltage less than 71% of nominal.	Blink Red
LINE 2	BYP:	ready	ac high	Input AC voltage greater than 110% of nominal.	Blink Yellow
LINE 2	BYP:	ready	AC HIGH	Input AC voltage greater than 112% of nominal.	Blink Red
LINE 2	BYP:	ready	AC FAIL	Input AC returned, inverter NOT phase locked.	Blink Red
LINE 2	BYP:	ready	ac warn	Input AC less than 85%, inverter phase locked.	Blink Red
				SYSTEM SET TO THE OFF-LINE (BYPASS) MODE.	Bypass LED
LINE 1	INV:	ready	normal	Inverter in stand-by, ready to operate	Blink Green
LINE 1	INV:	ready	dc low	Input DC less than 42 volts.	Blink Yellow
LINE 1	INV:	ready	dc high	Input DC greater than 57 volts.	Blink Yellow
LINE 1	INV:	off	DC LOW	Input DC less than 39.5 volts.	Blink Red
LINE 1	INV:	off	DC HIGH	Input DC greater than 60 volts.	Blink Red
LINE 2	BYP:	static	normal	External AC input powering load. Voltage in tolerance.	Green
LINE 2	BYP:	ready	ac low	Input AC voltage less than 85% of nom. On inverter	Yellow
LINE 2	BYP:	ready	AC LOW	Input AC voltage less than 71% of nom. On inverter.	Red
LINE 2	BYP:	ready	ac high	Input AC voltage greater than 110% nom. On inverter.	Yellow
LINE 2	BYP:	ready	AC HIGH	Input AC voltage greater than 112% nom. On inverter.*	Red
LINE 2	BYP:	maint	normal	Input DC breaker Off, input AC in tolerance.	Green
LINE 2	BYP:	maint	ac low	Input DC breaker Off, input AC less than 85% nom.	Yellow
LINE 2	BYP:	maint	AC LOW	Input DC breaker Off, input AC less than 72% nom.	Red
LINE 2	BYP:	maint	ac high	Input DC breaker Off, input AC greater than 110% nom.	Yellow
LINE 2	BYP:	maint	AC HIGH	Input DC breaker Off, input AC greater than 112% nom.	Red
LINE 2	BYP:	maint	ac warn	Input DC breaker Off, system recovering from AC hi/low	Yellow

NOTE: In the maintenance bypass mode, the load will be powered from the input AC source, independent of its voltage level.

* If inverter failure or DC input loss occurs, and AC input voltage is greater than 112% of nominal, the system will shut down to protect users equipment.

** If overload is not removed, unit will transfer to Bypass, Inverter Ready will be displayed (see specification).

The LCD can display a total of 10 different measurements, with two measurement values per line. The following is a list of measurements displayed:

Load Volts (Vrms)	%Load (higher of watts/VA)
Utility Volts (Vrms)	Frequency (Hz)
DC Input Volts (VDC)	DC Input current (Amps)
Load Watts	Load Current (Arms)
Inverter internal temperature (deg. C)	Inverter frequency (Hz)

To display a measurement, press and hold the UPPER or LOWER scroll switch until the LCD read-out changes to the desired measurement.

Figure **: Line 1 Measurement Readout**
1- 1A

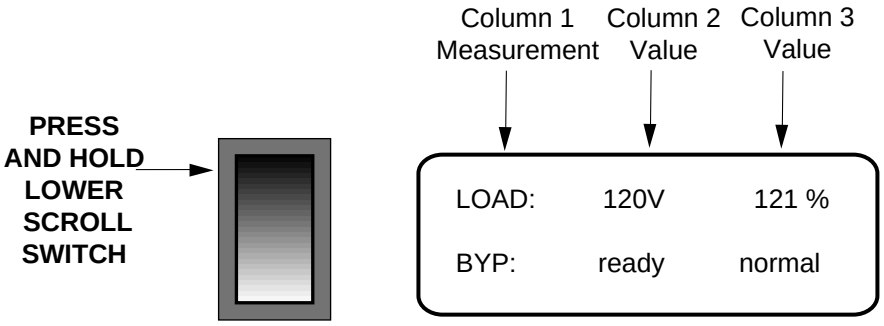
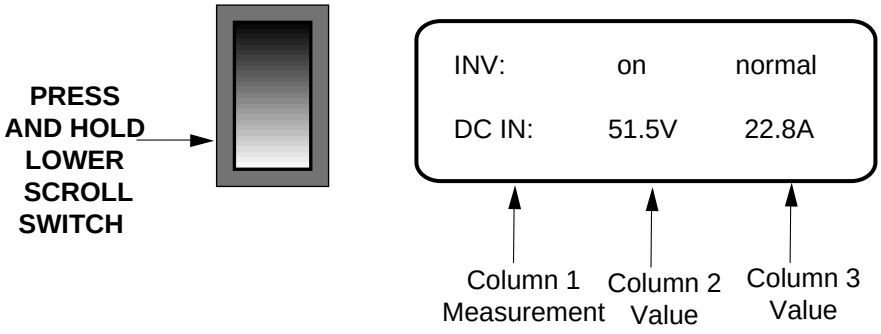
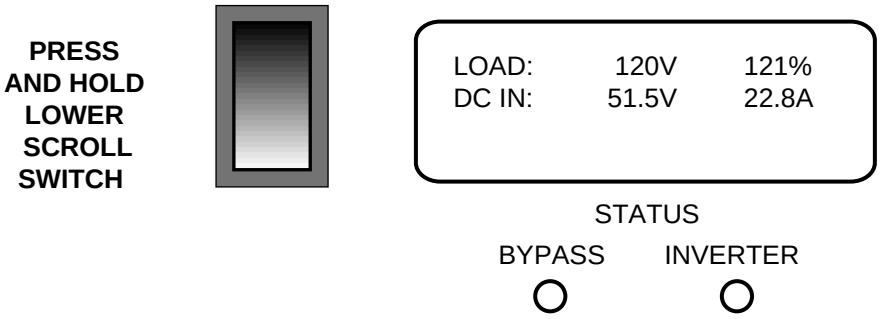


Figure **: Line 2 Measurement Readout**
1- 1B



The same measurements can be displayed on both Line 1 and Line 2 of the LCD, so it is possible to display up to four different measurements simultaneously.

Figure **: Line 1 and 2 Measurement Readout, Status Indicators**
1- 1C



1.6.2 Status Indicators (LEDs)

Two indicators are provided and identified as "STATUS". One indicator is labeled "BYPASS", the other "INVERTER". In normal condition, if the OFF-LINE (bypass) mode has been selected, the "BYPASS" LED will glow continuously and the "INVERTER" LED will blink ON and OFF. If the ON-LINE (inverter) mode has been selected, the "INVERTER" LED will glow continuously, the "BYPASS" LED will blink. Blink rate is one second on, one second off.

1.6.2.1 Bypass LED Color

GREEN -- Utility voltage and frequency within tolerance.

YELLOW -- Warning! Utility voltage or frequency not in tolerance.

RED -- Alert! Bypass abnormal. Utility voltage or frequency either too low or too high, can not transfer to bypass.

NOT ILLUMINATED -- Bypass not available.

1.6.2.2 Inverter LED Color

GREEN -- Inverter ON, no warnings or faults.

YELLOW -- Warning! -- Inverter overload or overload recovery cycle, thermal warning, or DC warning. -- Bypass abnormal.

RED -- Alert! Inverter not operating. Stopped for abnormal Inverter, overload, short circuit, thermal warning, DC warning, or DC circuit breaker OFF.

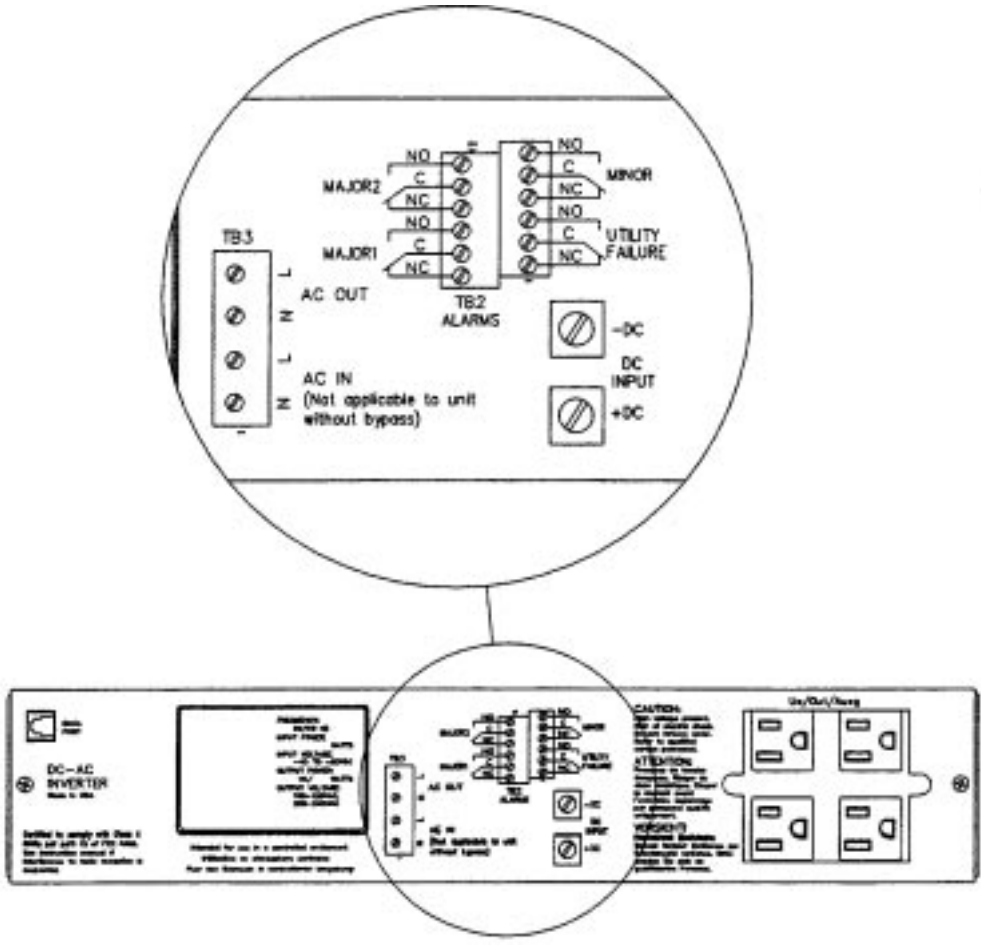
1.6.2.3 Lamp Test

At power up or software recovery, an automatic lamp test sequence will be automatically initiated. Both indicators will simultaneously go through a RED-YELLOW-GREEN lamp test sequence.

1.6.3 Remote Alarm Indication

Three alarm relays are provided. 1) UTILITY FAILURE, 2) MINOR alarm, 3) MAJOR alarm. All relays are identical, however the UTILITY and MINOR relays are wired as a SPDT units, whereas the MAJOR alarm relay is a DPDT unit. Relays are energized under normal operating condition. De-energizing of the relays results in an ALARM signal as shown in figure 1-2. Relay contact rating is 2 amperes maximum for 120/240VAC, 25 to 125VDC with a switched load of 50 Watts. Connection diagram is clearly labeled on the rear panel for these alarm relays. See Figure 1-2.

Figure 1- 2 **: Remote Alarm Connection Diagram**



1.6.3.1 Utility Failure (Only Available on Model With Static Transfer Switch)

Alarm if Utility voltage is not within proper limits. Contacts are:

TB2-1 = NC, TB2-2 - Common, TB2-3 = NO.

1.6.3.2 Minor Alarm (Only Available on Model With Static Transfer Switch)

A minor alarm will occur for any of the following:

1) inverter output or static transfer switch overload or short circuit.

2) thermal warning or fault.

3) Input DC loss.

4) Static transfer switch failure.

5) 4 transfers to bypass within 4 minutes (on-line mode).

Contacts are: TB2-4 = NC, TB2-5 = Common, TB2-6 = NO.

1.6.3.3 Major Alarm

A major alarm will occur when the load is not powered by the Inverter or the Utility AC (static transfer switch or maintenance bypass relay). Two sets of contacts are provided. Contact set 1 for utility failure alarm: TB2-7 = NC, TB2-8 = Common, TB2-9 = NO. Contact set 2 for inverter failure alarm: TB2-10 = NC, TB2-11 = Common, TB2-12 = N0.

1.6.4 Front Panel Controls

1.6.4.1 Input DC Circuit Breaker

A circuit breaker is located on the front panel and identified as "DC INPUT". Turning the breaker to the ON position will apply the input D.C. voltage to a capacitor bank through a resistor network to limit the inrush current. After a few seconds of delay, the DC capacitor bank voltage will be within a few volts of the input. Then a relay will close and apply the full battery voltage to the capacitor bank. After energizing of the relay, the Inverter will be allowed to operate. Placing the circuit breaker to the OFF position will disable the Inverter. If the BYPASS option is available, the unit will transfer to BYPASS, thus the load will be powered from the Utility power source through the BYPASS switches. The receiver cabinet contains a maintenance bypass relay to allow the inverter module to be removed without removing power from the load provided the BYPASS option is available.

1.6.4.2 Scroll Switch

This is a three position rocker switch and is associated with the digital LCD. The center position is OFF. Pushing the UPPER switch will allow scrolling through the various LINE 1 read-outs. Pushing the LOWER switch allows scrolling through various LINE 2 read-outs in the reverse direction.

1.6.5 Inverter Module Switches and Controls

When looking at the left hand side of the inverter module, openings are provided to select the output voltage (120 or 240 VAC) and switches to set up various commands to the microprocessor. See Figure 1-3A and Figure 1-3B.

Figure **: Inverter Module Configuration for .5kVA and 1kVA**
1- 3A

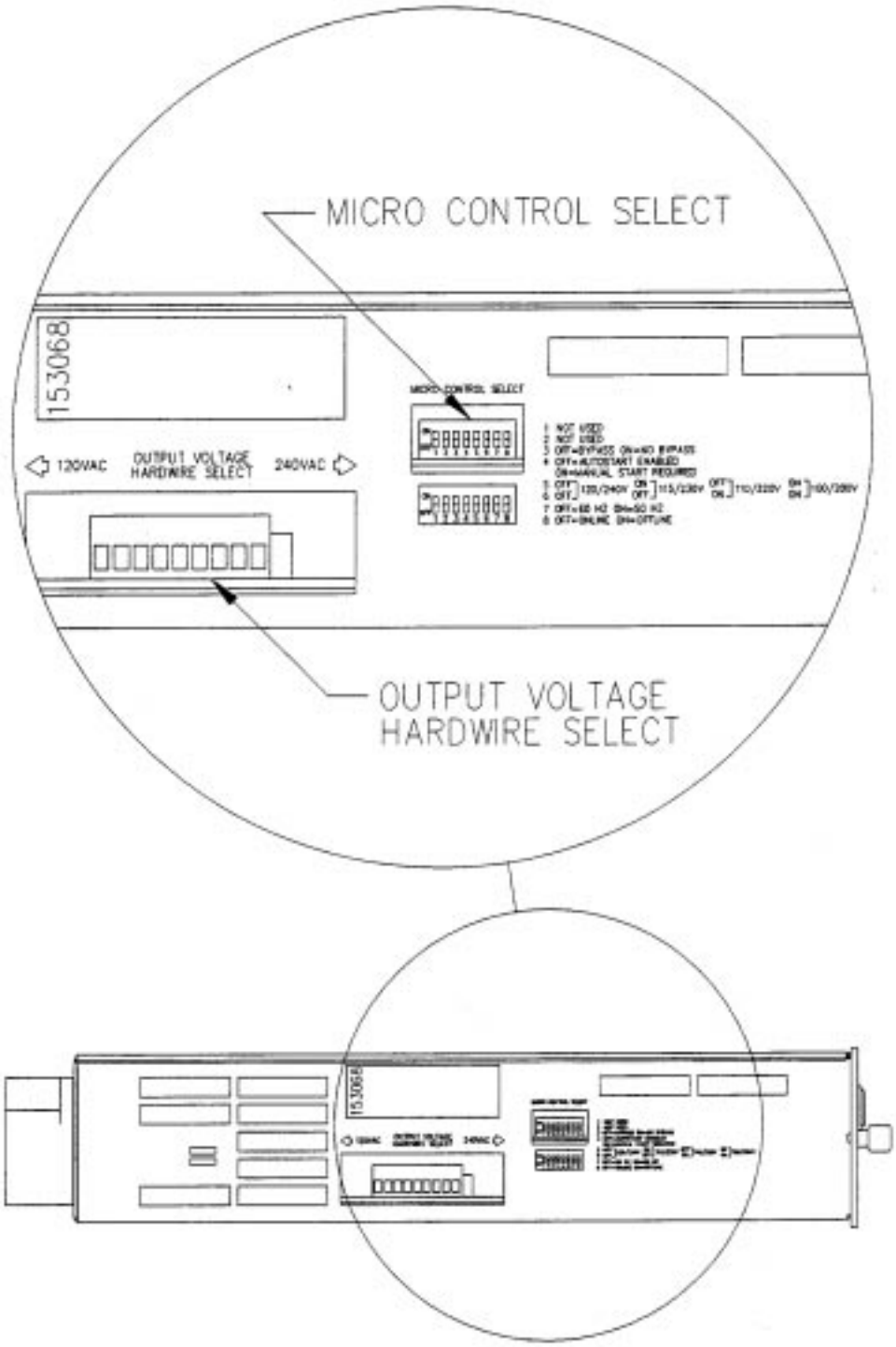
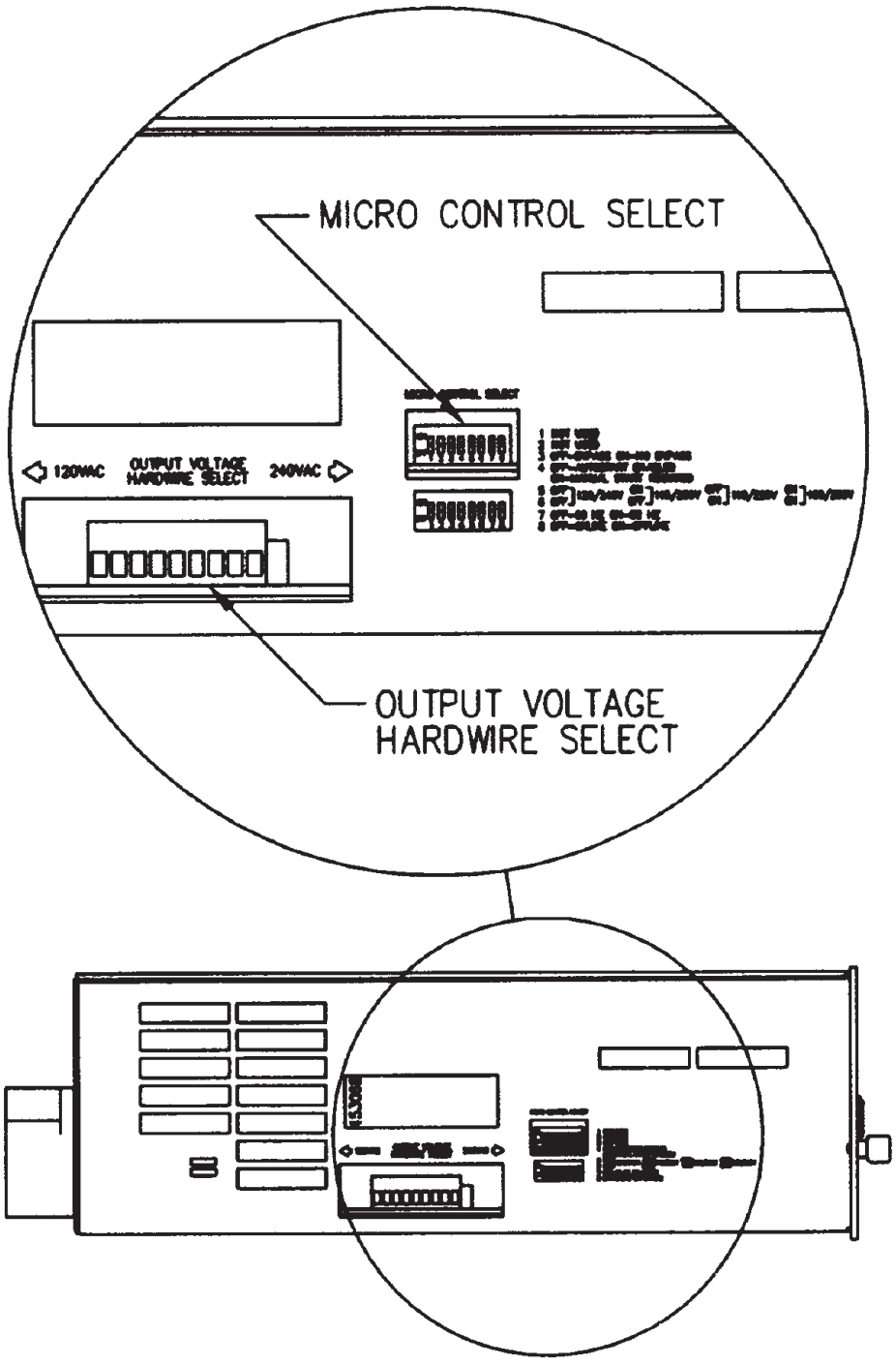


Figure : **Inverter Module Configuration for 2kVA**
1- 3B



1.6.5.1 Output Voltage Selection

Selection of the AC output voltage is accomplished by moving a connector plug. The printed circuit board has a 10 pin connector (J3) and its mate is a 9 pin plug (P3). Moving this plug to the left (rear) position selects the 120VAC position (100, 110, 115, 120 VAC). Moving of the plug to the right (toward the front panel) connects the inverter to produce 240VAC (200, 220, 230, or 240VAC).

WARNING

Modules with "BYPASS" option installed may be damaged when utility voltage and inverter output voltage settings are not the same.

ATTENTION

Un module avec l'option "BYPASS" risque d'être endommagé si les réglages de tension du réseau et de sortie onduleur ne sont pas les mêmes.

WARNUNG!

Nach Installation des "BYPASS" muss die Spannung dieselbe sein wie die Inverter Ausgangsspannung, ansonsten Beschaedigung des Inverter Module.

1.6.5.2 Micro-Processor "DIP" Switch Settings

An eight position DIP switch can be seen through the access hole in the left side of the inverter module. The switches are labeled "MICRO CONTROL SELECT". The switch functions are clearly labeled. Switch positions 1 and 2 are reserved and should be set to the OFF position. Switch position 3 is ON when no BYPASS option is installed, OFF when the BYPASS option is installed. Switch position 4 is OFF if AUTO RESTART is desired, ON if manual restart is desired. Switch position 5 & 6 select the output voltage of the inverter. Switches 5 & 6 OFF = 120 or 240 VAC output, 5 ON & 6 OFF = 115 or 230 VAC output, 5 OFF & 6 ON = 110 or 220 VAC output, 5 ON & 6 ON = 100 or 200 VAC. See Figure 1-3.

1.7 Mechanical Specifications

The inverter assembly consists of an inverter module which slides into the receiver cabinet. The receiver cabinet consists of a left and right side "U" channel and a rear housing which contains EMI filters, Maintenance bypass relay, Alarm relays, and wire termination points. The inverter module is an easily removable module which is secured into the receiver cabinet via two thumb screws. All input and output power and signal wires go through a single multi-pin connector located on the rear of the inverter module. See Figures 2-1 and 2-2.

1.7.1 Dimensions

These dimensions include both the receiver cabinet and the inverter module. Depth is inclusive of the inverter module thumb screws.

	0.5 kVA, 1 kVA	2 kVA
HEIGHT:	3.50 in (8.9 cm)	5.3 in (13.4 cm)
WIDTH:	17.0 in (43.2 cm)	17.0 in (43.2 cm)
DEPTH:	19.0 in (48.3 cm)	19.0 in (48.3 cm)

1.7.2 Weight

	0.5 kVA & 1 kVA	2 kVA
Receiver cabinet	8.0 lbs (3.63 Kg)	11 lbs (5 Kg.)
Inverter module	23.0 lbs (10.44 Kg)	31 lbs. (14 Kg.)
Total weight with mounting brackets	39.0 lbs (17.7 Kg).	51 lbs. (23.18 Kg.)

1.8 Environmental Specifications

1.8.1 Operating Temperature

Continuous overload to 125% of rated VA/Watts @ 50 degrees celsius maximum for 0.5 kVA & 1 kVA, and 120% of rated VA/Watts @ 40 degrees celsius for 2 kVA. Full output power/VA and short term (30 seconds) overload to 125% between -10 to +50 degrees celsius. Derate power/VA linearly to zero between +50 and +70 degrees celsius.

1.8.2 Non-Operating Temperature

-40 to +75 degrees celsius. for shipping, but not recommended for storage. See Section 2.3 for storage recommendations.

1.8.3 Operating Humidity

0 to 90% relative, without condensation.

1.8.4 Operating Altitude

To 10,000 feet above sea level. Derate maximum ambient of 50 degrees celsius by 3 degrees celsius per 1000 ft. at altitude above 3300 feet (30 degrees celsius maximum at 10,000 feet).

1.8.5 Audible Noise

Less than 60 dBA per Type 2, IEC and ANSI SI.4, 1981 when measured in a 55 dBA environment at a distance of 4 feet from any surface.

1.8.6 Cooling

Forced air. Air inlet is located on the front panel. Exhaust is out the sides of the receiver cabinet. See Figure 2-1.

Installation and Operation

2.0 Scope

This section describes the installation of the Topaz S3 0.5 kVA, 1 kVA, & 2 kVA including receiving, handling, storage, and installation procedures.

2.1 Receiving

Before accepting the shipment from the freight carrier, inspect the exterior surfaces of all shipping containers or packaging used, and the equipment, for damage that may have occurred during transit. If the shipping containers or equipment show evidence of damage, note the damage on the receiving document (bill of lading) prior to signing for receipt of equipment.

Damage claims should be filed directly with the carrier. Replacements for damaged components should be ordered through MGE Customer Support Services, @ 1-800-523-0142 ext. 476.

2.2 Handling

No special handling required.

2.3 Storage

If the equipment is to be stored prior to installation, it should be stored in a cool, dry, well-ventilated location that is protected against rain, splashing water, chemical agents, etc. The equipment should be covered with a tarpaulin or plastic wrapper to protect it against dust, dirt, paint, or other foreign materials.

2.4 Prerequisites to Installation

An efficient Topaz S3 installation depends on careful planning and site preparation. Installation of static inverter equipment must be handled by skilled technicians and electricians familiar with the special requirements of high-energy electrical equipment. The installation must comply with the requirements of the National Electrical Code (NEC, ANSI/NFPA 70, latest issue) and with local codes and requirements as applicable.

We strongly recommend contacting MGE Customer Support Services @ 1-800-523-0142 ext. 476 for system start-up. Do not allow unqualified personnel to handle, install, or operate the Topaz S3 inverter.

2.5 Installation

2.5.1 Location

The equipment is designed for installation in a protected environment. Factors to be considered in selecting a location include ventilation, environmental conditions, and accessibility. Optimum operation of the unit will be obtained by careful consideration of its location. Install the unit in a clean, dry location with an unrestricted air flow surrounding the equipment. See Figure 2-1A and Figure 2-1B.

Figure 2- 1A **: Outline and Mounting for .5kVA & 1kVA**

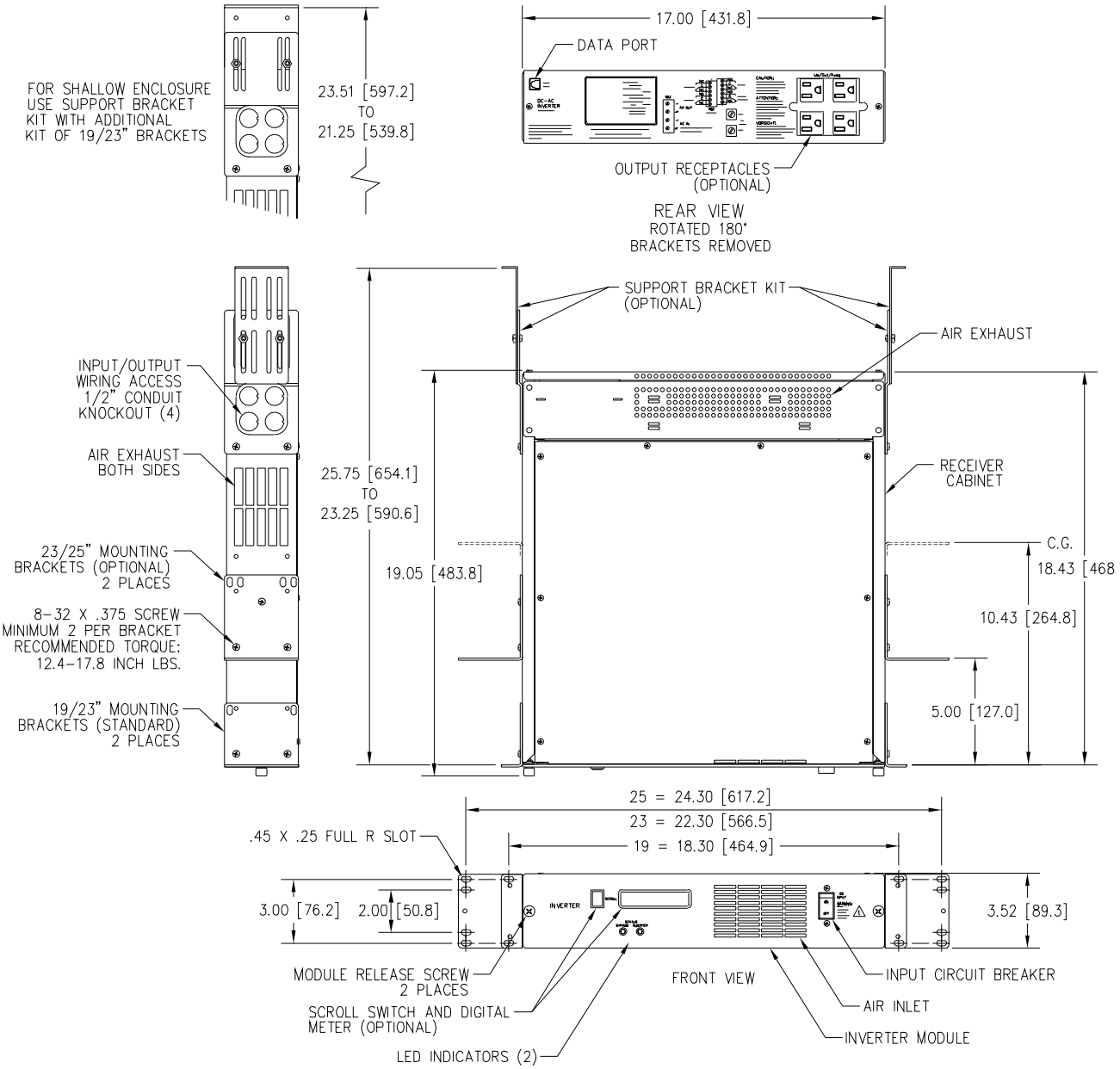
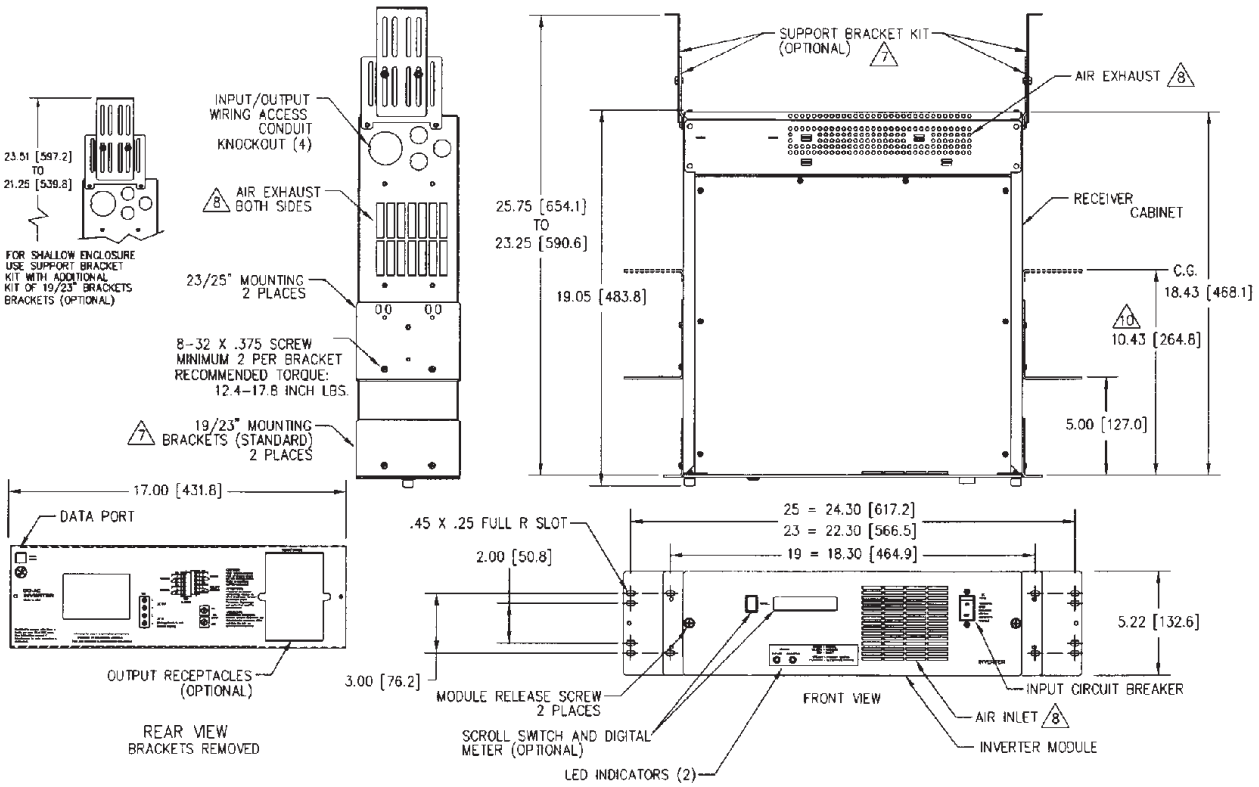


Figure : **Outline and Mounting for 2kVA**
2- 1B



2.5.2 Mounting And Wiring Access

The side mounting brackets can be positioned for either a 19 inch, 23 inch, or 25 inch rack. The Inverter can also be mounted either flush with the front panel or at the chassis midpoint. Prior to mounting the Inverter in the rack, determine the position of all input and output wiring.

NOTE

Input and output conductors must be sized for the maximum current as shown in Table 2-1 and otherwise be in compliance with applicable electrical codes. Be sure all connections are fully tightened. D.C. input terminals can accommodate wire size up to one "0" gauge wire.

Table 2- 1 **: Recommended Input/Output Wiring**

	Model	DC Input Current	AC Output Current	AC Input Current
Max. Current	63054	16 AMPS	5 AMPS	5 AMPS
Min. Wire Size	(500VA)	12 AWG	14 AWG	14 AWG
Max. Current	63104	30 AMPS	10 AMPS	10 AMPS
Min. Wire Size	(1kVA)	10 AWG	14 AWG	14 AWG
Max. Current	63204	60 AMPS	17 AMPS	17 AMPS
Min. Wire Size	(2kVA)	8 AWG	12 AWG	12 AWG

NOTE: Maximum circuit breaker rating for AC input shall be 20 Amperes, Maximum DC input current should be limited to 50 Amperes. Wire gauge for both AC and DC wiring shall be selected according to the national electrical code.

WARNING

This product is considered permanently connected equipment and must have a readily accessible disconnect device incorporated in the fixed wiring.

ATTENTION

Ce produit est considere comme equipement connecte en permanence et doit avoir un appareil de deconnexion facilement accessible incorpore dans le cablage fixe.

WARNUNG!

Dieses Produkt ist ein fest zusammengefuegtes Geraet und muss eine leicht erreichbare Abschaltungsvorrichtung im Leitungsnetz enthalten.

2.5.3 Grounding

For safety and proper operation of the unit, including maximum attenuation of electrical noise, suitable grounding is required. A separate grounding electrode conductor should be connected from the ground (GND) terminal to a nearby grounding electrode, and should be sized per National Electrical Code Article 250-94. The grounding electrode should be grounded structural metal, a metal water pipe, or a suitable ground rod (National Electrical Code, Article 250-26). The grounding electrode should be as near as possible to the unit.

2.5.4 Inverter Connection

After the inverter assembly has been attached to the rack, remove the Inverter module from its receiver cabinet using the two thumb screws and perform the following steps See Figure 2-2A and Figure 2-2B.

Figure **: Wiring Access and Connection for .5 kVA & 1 kVA**

2- 2A

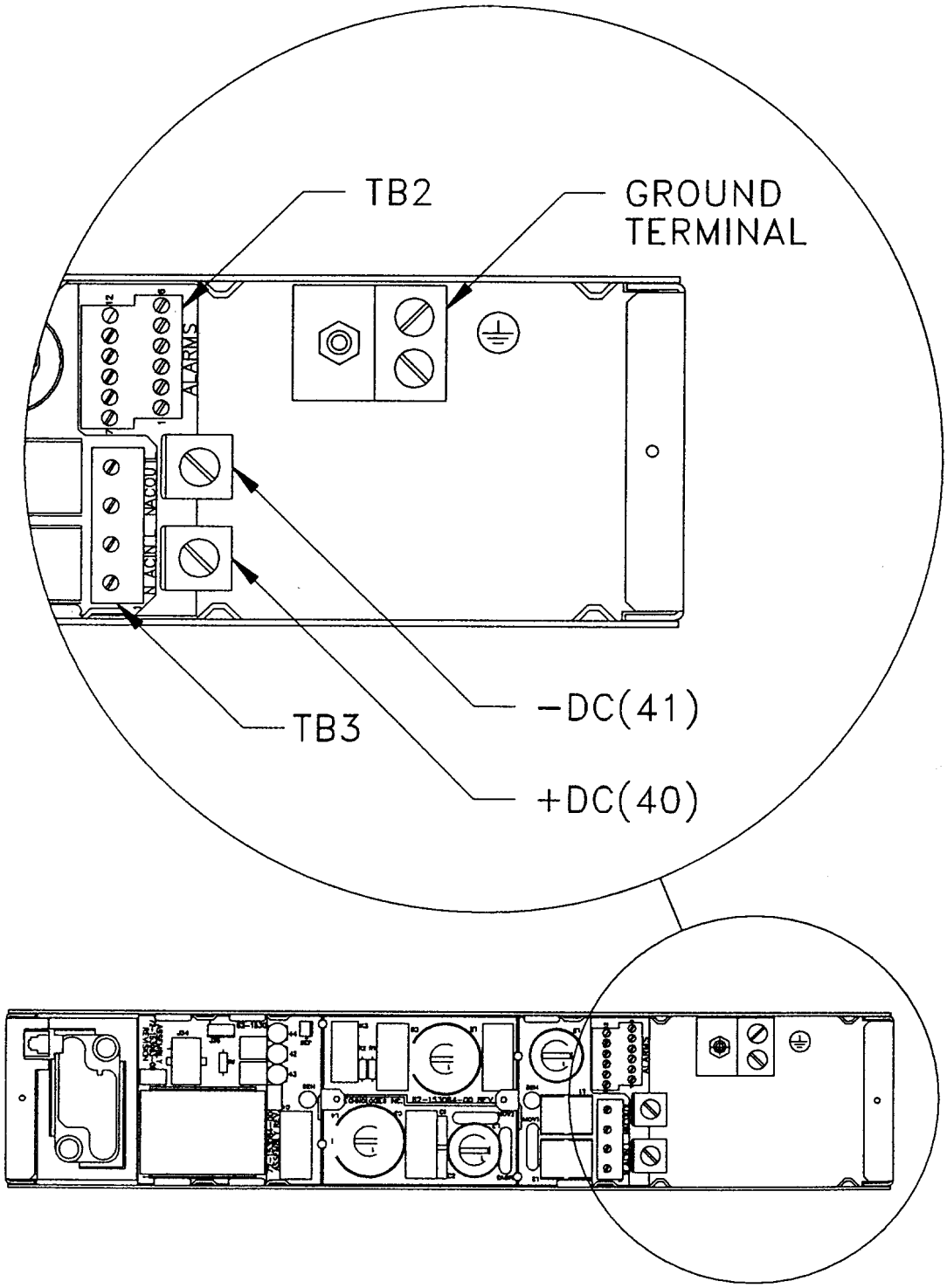
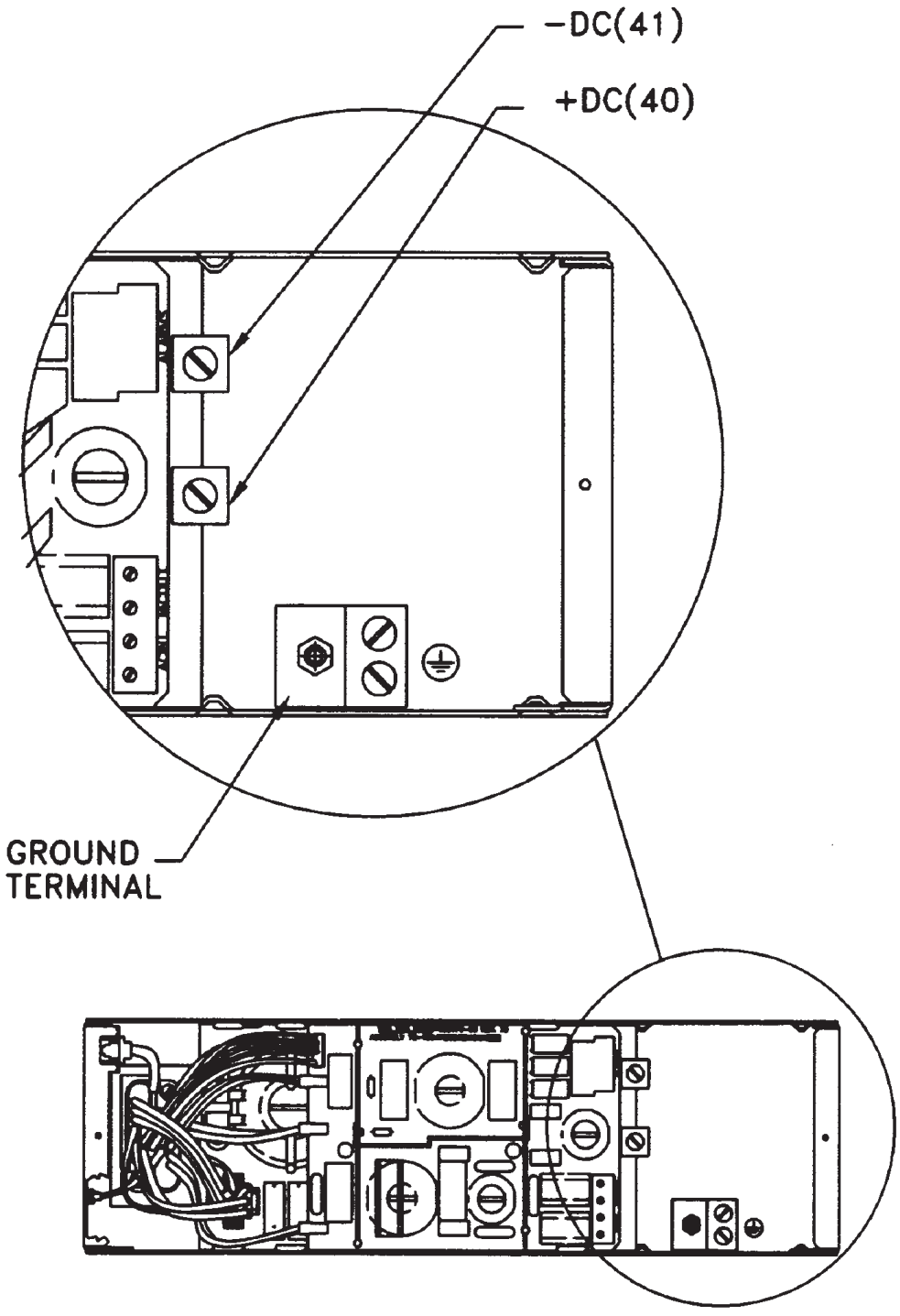


Figure : **Wiring Access and Connection for 2 kVA**

2- 2B



2.5.4.1 Hard Wire Access

Remove the cover plate on the rear of the inverter receiver cabinet to gain access to the wiring compartment.

2.5.4.2 Knockout Access

Route the DC input, AC output, AC input (Static Transfer Switch option), and alarm signal wires through the selected knockout holes, using the appropriate conduit bushings. Use knockout cutters to obtain the proper conduit/bushing sizes.

2.5.4.3 DC Hard Wire Connection

Be sure that the DC input conductors are connected POSITIVE to the +DC terminal (40) and the NEGATIVE to the -DC terminal (41).

NOTE

This inverter was designed with the intent that the user will terminate the positive polarity terminal of the DC source to earth or chassis ground. For a positive or floating DC input consult MGE Customer Support Services.

2.5.4.4 Alarm Hard Wire Connection

Before connecting the AC output wires or AC input wires (optional), the ALARM wires should be connected to TB2. Refer to Figure 1-2 for proper wiring. Alarm relays are shown in their "ALARM", de-energized position. MAJOR alarm (no power to the load) terminals are TB2-7 to TB2-12. MINOR alarm (Inverter Stopped) terminals are TB2-4 to TB2-6. Utility failure (if Static Transfer Switch option is installed) terminals are TB2-1 to TB2-3.

2.5.4.5 AC Hard Wire Connection

AC output is on terminal block TB3, marked "AC OUT". Make sure the white NEUTRAL wire is connected to AC OUT "N" and the LINE or HOT wire is connected to AC OUT "L". If a Static Transfer Switch option is installed, connect the Utility AC input to terminal block TB3, marked "AC IN". Again make sure the white NEUTRAL wire is connected to AC IN "N" and the LINE or HOT wire is connected to AC IN "L" terminal.

WARNING

AC output will be present at the output terminals immediately when AC input is energized even without the inverter module installed in the receiver cabinet.

ATTENTION

La tension alternative de sortie appara ît dès la mise sous tension de le'entrée, même si le module onduleur n'est pas installé.

WARNUNG!

Die Netzausgangsspannung ist unmittelbar an den Ausgangsklemmen, sowie der Netzeingang angeschlossen wird-slebst wenn der Einschub nicht im Gestell ist.

2.5.5 Cooling

For optimum inverter performance, provide ventilation clearance from exterior surfaces as follows:

Top and bottom: 0.25 inches [6.3 mm]

Front and sides: 1.50 inches [38.1 mm]

2.6 Inverter Set UP

- Verify the inverter module is NOT installed into its receiver cabinet.
- After the receiver cabinet has been wired, verify that a separate grounding electrode has been connected to the chassis "GROUND" lug.
- Turn on the Utility AC and verify the proper AC voltage exists at ACIN "L" with respect ACIN "N" and chassis "GROUND".
- Turn on the DC supply to the unit.
- Verify polarity of the DC voltage, positive on "+DC" and negative on "-DC".
- Turn OFF all AC and DC power to the receiver cabinet.
- The Inverter module is delivered from the factory set for 120 VAC, 60 Hz , auto-restart, ON LINE (Inverter) mode operation.
- See Figure 1-3 and perform the following steps for a personalized inverter set up.

2.6.1 Voltage Selection

Viewed from the left side of the Inverter module, access holes can be seen for selecting the AC output voltage via a 120VAC/240VAC hard wired connector plug, and setting of the MICRO CONTROL "DIP" switches. If low output voltage is desired (100 to 120VAC) the jumper plug must be in the 120VAC position, toward the rear of the unit. If high voltage output is desired (200 to 240VAC) then the jumper plug must be removed and placed in the 240VAC position, side toward the front panel. Also make sure the MICRO CONTROL SELECT "DIP" switches 5 and 6 are set to the desired voltage position. For 120VAC or 240VAC output, switch 5 must be OFF, switch 6 OFF. For 115VAC or 230VAC, switch 5 must be ON, 6 OFF. For 110VAC or 220VAC, switch 5 must be OFF, 6 ON. For 100VAC or 200VAC, switch 5 must be ON, 6 ON.

2.6.2 Frequency Selection

With the Static Transfer Switch option installed, the frequency selected must be the same as the utility AC frequency. If the Utility frequency is 60 Hz and the Inverter is set for 50 Hz, the microprocessor can not phase lock to the input, and consequently transfer from Inverter to Utility for overload or Inverter shut down can not be accomplished without causing transients on the output. During start up of the Inverter, the load is always powered from the Utility and upon transfer to the Inverter, the output voltage will transfer at some unknown phase. So if 60 Hz operation is desired, set the MICRO CONTROL SELECT "DIP" switch 7 to OFF for 60 Hz, ON for 50 Hz.

2.6.3 Bypass

If the Static Transfer Switch is installed, the MICRO CONTROL SELECT "DIP" switch 3 must be set to the OFF position. If the Static Transfer Switch option is not installed, set this switch to the ON position.

2.6.4 On-Line, Off-Line Operation

If the Static Transfer Switch option is installed , either the ON line (output from the Inverter) or OFF line (output from the Utility power source) mode of operation may be selected. To select the ON line (Inverter) mode, set MICRO CONTROL SELECT "DIP" switch 8 to OFF. For OFF line (Utility) operation, set switch 8 to ON.

2.6.5 Automatic Restart

Some users do not want the Inverter to automatically restart upon application of DC power to the unit. Under this condition, set the MICRO CONTROL SELECT "DIP" switch 4 to ON (manual restart required by turning the DC circuit breaker OFF and then back to ON). If it is desired that the Inverter automatically start up upon application of DC, the MICRO CONTROL SELECT "DIP" switch 4 must be set to the OFF position.

2.7 Operation

When all selections have been made, perform the following steps to operate the inverter:

A) Be sure that all loads are disconnected or turned OFF and AC input power to models with a Static Transfer Switch is OFF.

B) Refer to the installation checklist in Table 2-1 (page 4-3)and be sure that all control settings and terminal block screws are tight.

C) Check again to see that the DC voltage on the inverter identification label matches the voltage of your power source.

D) Set the DC input breaker located on the front panel of the Inverter module to the OFF position.

E) Install the inverter module into its receiver cabinet and tighten the two thumb screws.

F) Apply a DC voltage to the DC input terminals.

G) Again, using a voltmeter or polarity tester, verify the voltage at the DC input terminals, positive on +DC (40) and negative on -DC (41).

H) Turn ON the DC circuit breaker. Within less than a second, a relay will energize which should be audible. Then the "STATUS" indicators will sequence through their RED, YELLOW, GREEN lamp test sequence. The alarm relays will also be cycling through various states as the lamp test is progressing. As the battery booster starts, a "chirp" sound may emanate from the unit. The Inverter will start, producing the appropriate voltage/frequency on the ACOUT terminal block, TB3. The "STATUS" indicator for the "INVERTER" should be illuminated Green. Verify the proper output voltage with a voltmeter at TB3. The "STATUS" indicator "BYPASS" should be RED, blinking ON and OFF at a 1 second rate.

I) Turn On the Utility AC and verify the "STATUS" indicator identified as "BYPASS" turns GREEN and continues to blink ON and OFF at a 1 second rate, indicating the Inverter is powering the AC output. If BYPASS indicator is a steady GREEN color, the "INVERTER" LED should be GREEN, blinking ON and OFF, indicating that the Utility is powering the AC output. The mode was selected in paragraph 2.6.4.

J) Units with the DIGITAL LCD option. Scroll through the readout menu using the SCROLL push-button and verify the DC input, AC input if applicable, and AC output voltages agree with the voltmeter readings previously taken.

K) Turn the DC circuit breaker on the front panel to the OFF position. Verify that AC voltage is still on the AC OUT terminal block TB3.

L) Loosen the thumb screws securing the Inverter module into its receiver cabinet and remove the module. Verify Utility voltage is still on the output terminal block, TB3.

WARNING

Module may be damaged if removed with the DC breaker closed.

ATTENTION

Le module risque d'être endommagé s'il est retiré avec le disjoncteur DC fermé.

WARNUNG!

Entfernung des Moduls mit geschlossenem Gleichstromunterbrecher koennte zu Schaden fuehren.

M) Turn OFF all the AC and DC input voltages.

N) Reinstall the Inverter module. Inverter is ready for operation. Connect loads and turn ON the unit.

Theory of Operation

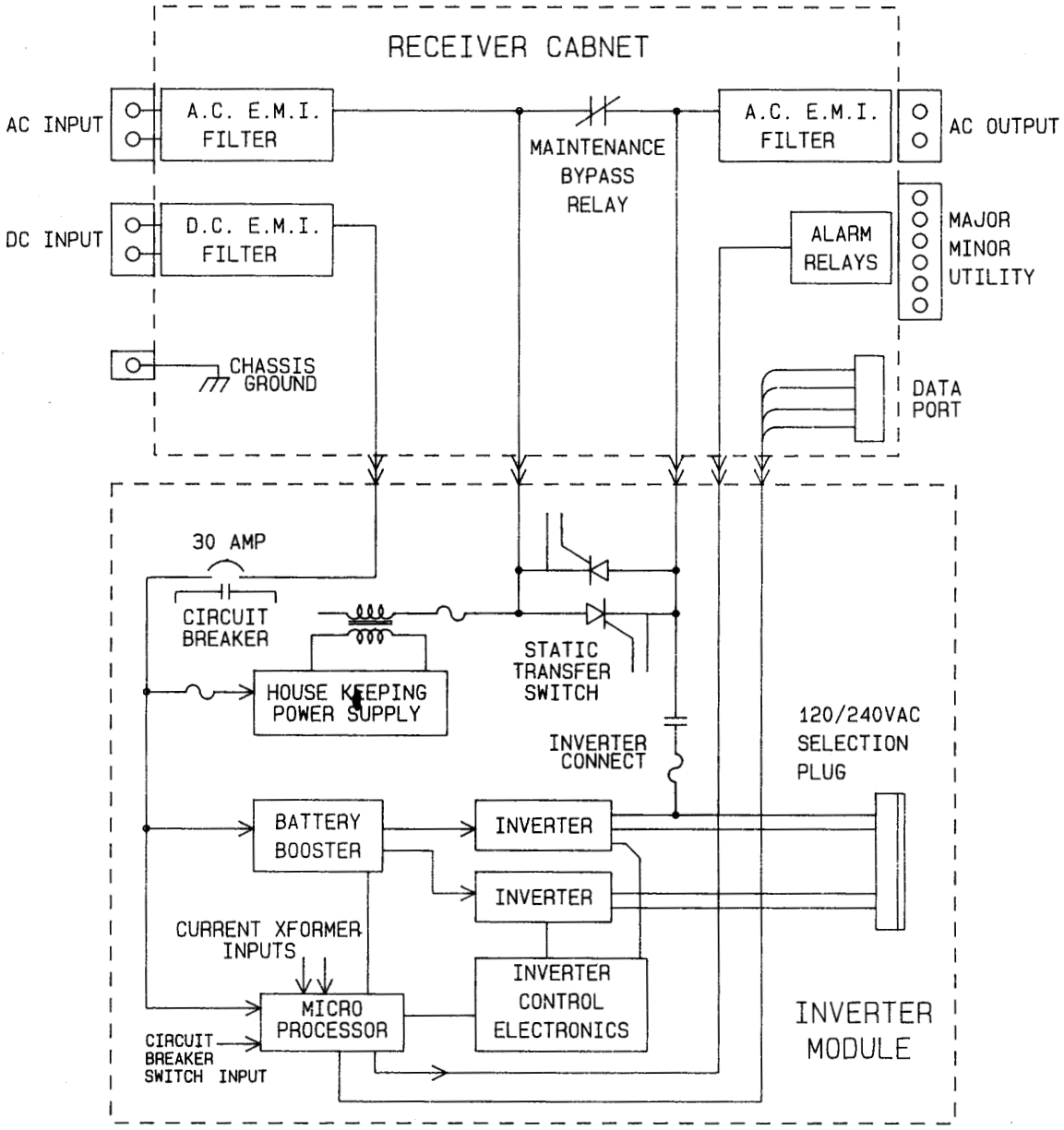
3.0 Scope

This section describes the theory of operation of the Topaz S3 Inverter systems.

3.1 General Description of the Inverter

The inverter utilizes a "Fly-back" converter to boost the input voltage to two regulated +/- 200 volt outputs. Two identical inverters are contained in the unit, both inverters controlled by a single PWM to generate sinusoidal AC outputs. The two inverters can be connected in parallel to produce 120 VAC output or connected in series for 240VAC output. This approach minimizes the size and weight of the magnetics since both the battery booster and inverter operate at relatively high frequency, greater than 20 kHz. A modular approach was taken which allows easy field replacement of the inverter module without removing power from the load. Figure 3-1 is a block diagram of the inverter.

Figure 3- 1 : **Inverter Block Diagram**



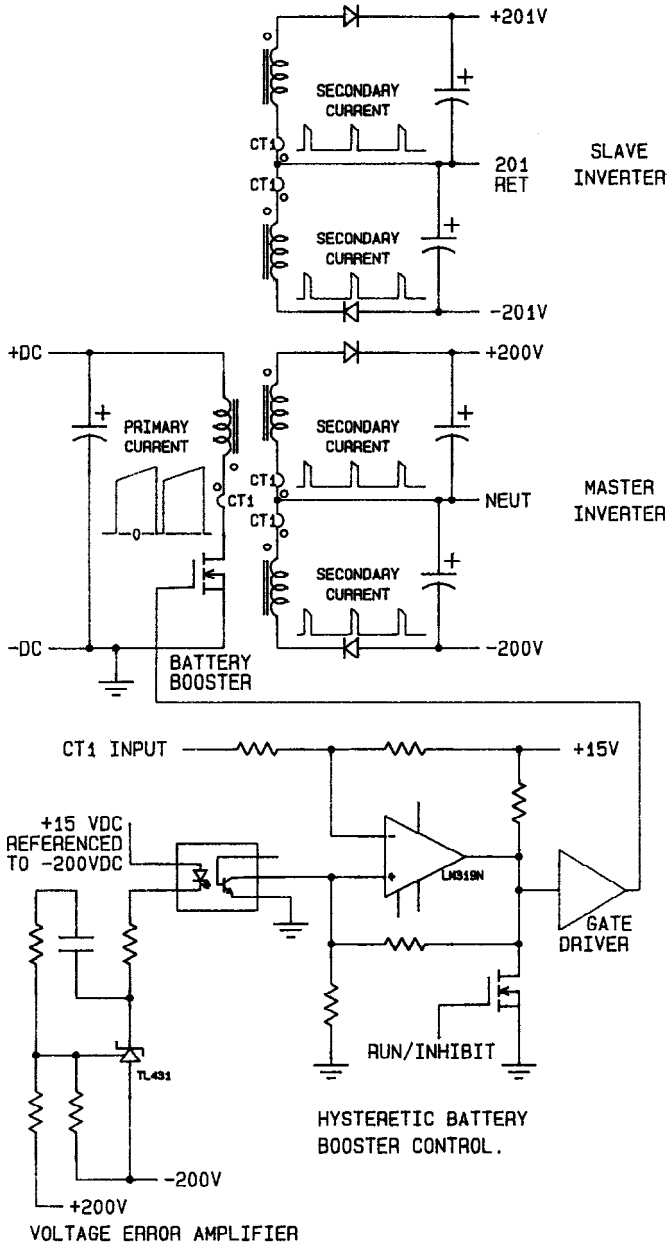
3.1.1 Battery Booster

The battery booster is a "continuous" mode Fly-back converter which takes the DC input voltage and boost it to four separate outputs of 200 volts. Two of these outputs are connected in series to produce -200 VDC and +200 VDC and used by one of the Inverters. The other two outputs are also connected in series to produce a second -200 and +200 VDC to be used by the second Inverter. The booster transformer, which is actually a coupled inductor, is used to isolate the primary DC input from the two +/-200 VDC outputs used to generate the two AC outputs. The total DC bus voltage (+/-200 volts) of one inverter is regulated. Feedback is provided through an analogue optical coupler to control a hysteretic current mode switch.

3.1.1.1 Hysteretic Booster Operation

Figure 3-2 shows the basic concept of the booster. The voltage error amplifier (TL431) measures the +/-200 VDC bus (400 volts total) of one of the Inverters and provides an error signal (via an optical coupler) to a comparator. If the +/-200 volt bus is lower than normal, the voltage applied to the positive input of the comparator will become higher, a demand for more current. A "DC" current transformer measures the current in the primary and secondaries of the "coupled inductor". The output of the DC current transformer is applied to the negative input of the comparator. When the inductors current has reached the required level, as measured by the DC current transformer, the comparator turns OFF, thus turning the Boost switch OFF. Now the energy stored in the coupled inductor is transferred to the output energy storage capacitors of the four 200 volt outputs. Since the turns ratio of the coupled inductor (transformer) is 1:1:1:1:1, all four DC outputs will be at the same voltage. A resistor placed between the positive input and output of the comparator controls the hysteresis level. The hysteresis current is set at 7.5 A. When the measured current falls below the hysteresis level applied to the positive input of the comparator, the comparator turns back ON, which turns ON the boost switch. Now the cycle starts all over again. The operating frequency of the battery booster is a function of input and output voltage, ranging between 20 kHz to 35 kHz. Since the booster switch (parallel FET) turns ON before the current in the output secondaries of the transformer goes to zero, the primary current starts at some level set by the hysteresis level. This is called a "CONTINUOUS" mode Flyback converter.

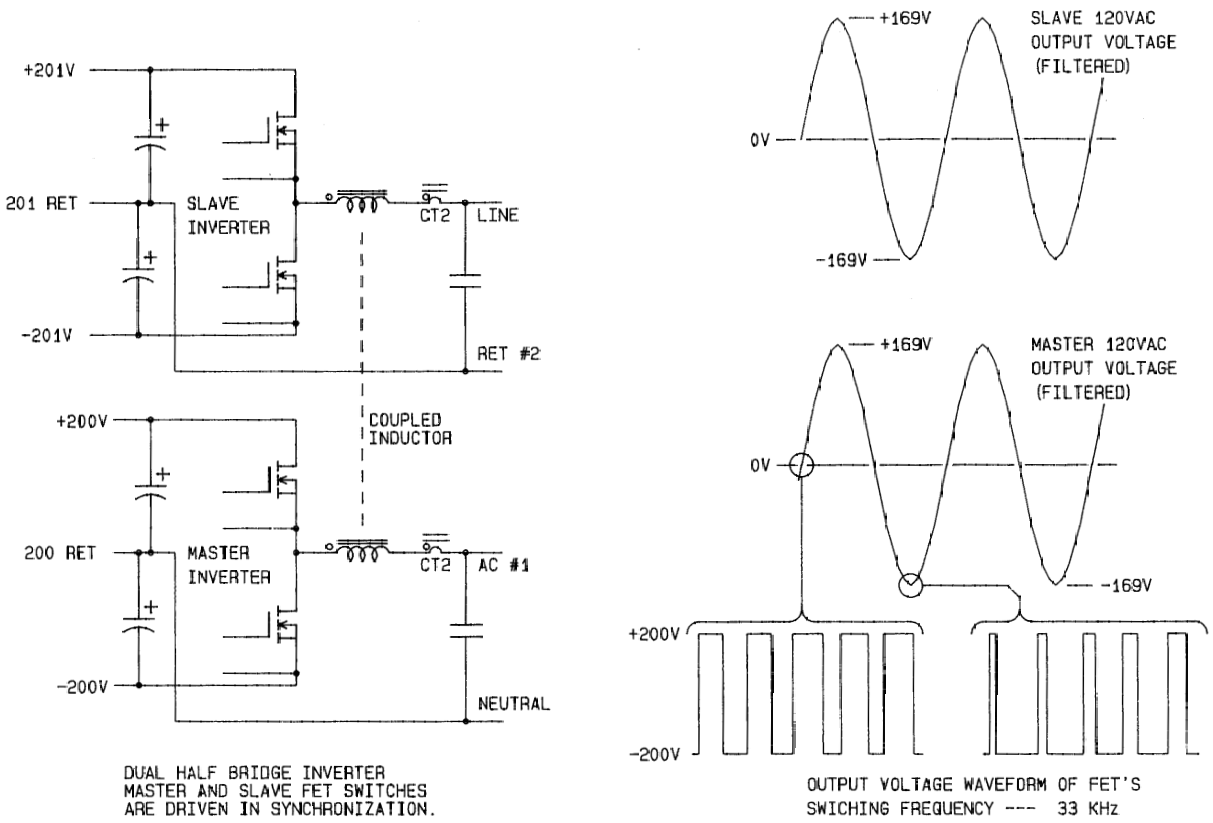
Figure 3- 2 **: Hystertic Booster Diagram**



3.1.2 Dual Inverters

As indicated, two identical inverters are used to produce either 120 or 240VAC depending on parallel or series connection of their outputs. Each inverter is a conventional half bridge, that is, only two FET switches are used in each inverter. See Figure 3-3. The output of each inverter is applied to a coupled choke. Since the choke acts as a transformer, the two windings of the choke must have the same voltage at any given time. Therefore if all four of the 200 VDC capacitors are at the same voltage, the output of the two inverters must be identical (within 2% of one another). Note that the FET switches are driven in synchronization. Control of the inverter is unique in that the inverter uses what is called "Average Current Mode Control". This is actually a control of the choke current and results in excellent dynamic response to step loads, overloads, and short circuits.

Figure 3- 3 **: Dual Inverter and Waveform Diagram**



DUAL HALF BRIDGE INVERTER
MASTER AND SLAVE FET SWITCHES
ARE DRIVEN IN SYNCHRONIZATION.

OUTPUT VOLTAGE WAVEFORM OF FET'S
SWICHING FREQUENCY --- 33 KHz

3.1.2.1 Average Current Mode

A microprocessor is used in the Inverter system to generate a reference sine wave via one of its three PWM outputs. The PWM signal is filtered to make a clean sine wave. This sine wave is applied to a voltage error amplifier. The other input to the voltage error amplifier is the output of one of the inverters, called the master inverter. The voltage error amplifier controls the amount of current the inverter supplies to its output filter capacitor and output load. A second amplifier (current error amplifier) compares the current command (voltage error amplifier output) to the choke current (voltage from another DC current transformer) and produces an error signal which is applied to a motor control PWM chip which completes the loop. Operating frequency of the Inverter is 33kHz, generated by the motor control chips oscillator.

3.1.2.2 Reference Sine Wave and Control

The microprocessor is used to enable and disable the battery booster, generate the sine wave reference signal, enable and disable the Inverter, measure battery current/voltage, Utility current/voltage/frequency, Output current/voltage/frequency, provide LCD metering data, and communicate with other equipment. Selection of the Inverter's output voltage and frequency (as set by the DIP switch) is accessible through the side of the inverter module. Isolation between DC input electronics and AC output (Line side) electronics is via high speed optical couplers. If Utility voltage is present and its frequency is close to the setting on the DIP switch, then the sine wave reference signal will become phase locked to the Utility. Frequency slew rate is less than 1 Hz per second, phase error will be less than 6 degrees. The microprocessor is supplied by power from the DC input side and the sine wave reference must be provided to the Inverter, located on the secondary (AC output) side. A high speed optical coupler is used to get the PWM signal to the Inverter electronics. This PWM signal is filtered by a two stage R-C filter and then buffered before it is applied to the voltage error amplifier. Enable/disable of the Inverter by the microprocessor is also via this same optical coupler. Feedback of the input and output AC voltage is accomplished by using the motor control PWM oscillator (triangle wave shape, ramping linearly between +4 and -4 volts at 33 kHz rate) to make a PWM signal. This signal is applied to an optical coupler, buffered, and filtered to produce an isolated replica of the AC voltages. The microprocessor has eight analogue inputs, two of which are used to measure the AC signals. Other inputs to the micro are: Inverter output current, Utility current (for back feed protection), battery voltage, battery current, and two heat sink temperatures.

3.1.3 Static Transfer Switch and Maintenance Bypass Relay

This is an optional feature that is described below.

3.1.3.1 On-Line, Off-Line Mode, and Static Transfer Switch

The ON LINE mode is defined as allowing the load to operate from the Inverter instead of the Utility power. If the Inverter should fault for some reason (overload, short circuit, over temperature, DC voltage not within specification, or Inverter failure) the system will transfer to the "BYPASS" mode (through the Static Transfer Switch) if the Utility voltage is within proper limits. For severe overloads, the Maintenance Bypass relay located in the receiver cabinet will be de-energized, shorting out the Static Transfer Switch, thus preventing damage to the Static Transfer Switch. The advantage of ON LINE operation is that the AC output is at a fixed voltage level and frequency and is free of all of the transients, sags, and brown out conditions that occur on the Utility power grid.

3.1.3.1.1 Static Transfer Switch

The Static Transfer Switch is a pair of back to back SCRs located in the inverter module. The SCRs are turned on as soon as the Utility voltage is present. It is commanded OFF by the microprocessor. The receiver cabinet also contains a maintenance bypass relay which is connected in parallel with the SCRs. The relay needs to be energized to open the contacts that parallel the SCRs. Energizing of this relay is also under the control of the microprocessor. Power to the microprocessor is from the utility and the DC input.

3.1.3.1.2 Start Up Sequence

When the inverter is enabled (by turning ON the front panel DC circuit breaker) the microprocessor goes through its start up sequence, including phase locking the reference sine wave to the Utility AC input. Then the maintenance bypass relay is energized, opening its contacts. The inverter is turned ON to check its functional operation, then turned back OFF. The Inverter output relay is closed , Inverter enabled and the Static Transfer Switch (SCRs) are turned OFF. This sequence is accomplished without any break (less than 1 millisecond) in output voltage to the load. If a severe overload should occur, the static transfer switch (SCRs) will be turned back ON and the Inverter disabled until the overload is removed. For overloads greater than 150%, the maintenance bypass relay will be de-energized, effectively shorting out the SCRs. Other overloads and failure of the Inverter will also cause transfer to the bypass mode. The DIP switch accessible through a opening in the side of the Inverter module must be set to the proper position to achieve this mode of operation.

3.1.3.2 Off-Line Mode

This mode allows the load to be powered at all times from the Utility power source through the Static Transfer Switch. The maintenance Bypass relay will be energized (contacts open). When the DC circuit breaker (on the front panel) is turned ON, the inverter will go through a sequence similar to that defined above, except the Inverter will not be powering the load. Transfer to the Inverter will occur only if the Utility voltage fails to be within specified limits (-20% to +10%). The STATUS indicator will blink indicating the inverter status. The DIP switch located on the side of the Inverter module must be set to the proper position to obtain this mode of operation. Advantage of OFF LINE mode is that the system is more efficient. Only a small amount of power is required by the Inverters electronics (less than 30 watts).

3.1.4 Digital LCD Display

The digital LCD has two lines of 20 characters. A "SCROLL" switch allows scrolling through the display messages which include as a minimum: Utility voltage and utility frequency (only with static transfer switch), output voltage , output current, output frequency, input DC voltage, input DC current, percent load. All of this data is supplied to the LCD from the microprocessor.

3.1.5 Status Indicators (LEDs)

Two LEDs are on the front panel identified as "STATUS". The left most LED is for "BYPASS" status and the right LED is for "INVERTER" status.

3.1.5.1 "Bypass"

A blinking LED indicates that the load is powered by the Inverter, not from the Utility. The "BYPASS" LED will be illuminated Green if the Utility is within acceptable voltage and frequency limits as specified by the 50/60 Hz DIP switch setting. Yellow indicates the Utility is not within proper limits. Red indicates the utility is out of tolerance, do not transfer to bypass. Not illuminated indicates that bypass is not available.

3.1.5.2 "Inverter"

A blinking LED indicates that the load is being powered by the Utility source and not from the Inverter. Green indicates the Inverter is ready to power the load. Yellow indicates Inverter warnings for overload or overload recovery cycle, thermal DC, and bypass abnormal conditions. Red indicates the Inverter can not operate properly. LED not illuminated indicates the inverter is not ON.

3.1.6 Power Supply

An internal power supply is used within the inverter module which makes several 15 VDC outputs from the -48 VDC battery input and/or utility AC power through a transformer and bridge rectifier. The 15 volt outputs are used to power the AC side electronics (+ & - 15VDC for the control circuits, one +15 VDC output to operate the "master" inverters half bridge driver), and a second +15 VDC output to operate the "slave" inverters half bridge driver. Battery side electronics (hysteretic battery booster and microprocessor) also requires + & - 15 VDC.

3.1.6.1 Supply Description

The power supply is a discontinuous mode "Flyback" supply, that is, the current in the "Flyback" transformer is zero at the beginning of every switching cycle. The supply was designed to produce an output power of 20 watts from D.C. input voltages ranging from 35 VDC to 80 VDC. Control of this supply is by an industry standard UC3842AN current mode control PWM chip operating at 100 kHz. The +15 VDC output on the Battery side (D.C.) is the regulated voltage. Tight coupling of the transformer ensures that all other outputs are reasonably close to 15 volts. Within the UC3842AN integrated circuit, the voltage error amplifier positive input terminal is set at one half of the chip's reference (+5.00 volts). So the negative input terminal (VFB) must also be at +2.50 volts. A 2490 ohm resistor is connected from the VFB terminal to ground (1.00 mA.) To obtain +15 VDC, we need 12.5 volts across a resistor at 1.0 mA, or 12,500ohms. A 12400 ohm resistor was used and the +15 VDC is actually 14.95 volts.

3.1.6.2 Supply Operation

The duty cycle of the UC3842ANs oscillator is set up to be about 45%. The output of the chip drives the gate of an IRF840 FET. The "Drain" of the FET is connected to a "Flyback" transformer (actually a coupled inductor of 50 uHy primary inductance). At the beginning of the switching cycle, the FET is turned ON. Current starts to build up linearly in the primary of this inductor. A resistor located in the "Source" lead of the FET is used to measure the current in the primary of the transformer. This signal is applied to the UC3842ANs current sense port. When this voltage (current in the transformer's primary) reaches the correct level as determined by the chip's voltage error amplifier output, the FET is turned OFF. Now the energy stored in the "Flyback" transformer is transferred into the output capacitors. Remember! Energy (Watt -seconds) times the number of energy bundles per second is equal to Watts. If the transformer windings are tightly coupled, all windings should receive the needed energy to keep all of the outputs at the same voltage. If the +15 VDC output should become higher than desired, the voltage error amplifier will start to decrease its output and thus reduce the amount of energy being supplied to the output capacitors. If the error amplifier's output should become less than one volt, no energy will be stored in the transformers and thus no energy will be transferred to the output capacitors.

Maintenance and Service

4.0 Scope

This section describes maintenance and service of the Topaz S3 Inverters Systems, including safety instructions, preventive maintenance, descriptions of replacement parts kits, and service.

4.1 Safety Instructions

IMPORTANT SAFETY INSTRUCTIONS FOR SERVICING INVERTER SERVICING SHOULD BE PERFORMED OR SUPERVISED BY QUALIFIED PERSONNEL ONLY.

WARNING

DC input power to the inverter is normally from a battery bank with a very high short-circuit capacity. Accidental welding and severe burns can be caused by mistakes while connecting or disconnecting these conductors.

ATTENTION

L'entrée DC de l'onduleur est normalement alimentée par une batterie avee un courant de court-circuit élevé. Une erreur lors de la connexion ou deconnexion de ces conducteurs peut causer des soudures accidentelles et des brûlures sérieuses.

WARNUNG!

Gleichstrom zum Wechselrichter kommt gewoehnlich von der Batteriebank mit einer sehr hohen Kurzschluss Leistungsfaehigkeit. Unbeabsichtigtes Schweissen und schwere Verbrennungen koennen die Folgevon fehlerhafter Verbindung und Trennung sein.

4.2 Preventive Maintenance

The following preventive maintenance routines should be considered the minimum requirements; your installation and site may require additional preventive maintenance to assure optimal performance from your installed Topaz S3 series Inverter System and associated equipment. We strongly recommend contracting MGE Customer Support Services for preventive and remedial maintenance.

The technician or electrician performing preventive maintenance on the inverter must be familiar with the indicators, controls, and operation of the inverter, as described in this manual.

a. Ensure that all equipment is clean and free of loose dust, dirt, and debris. The exterior of all enclosures may be cleaned with a mild solution of soap and water, lightly applied with a lint-free cloth.

b. Inspect the air intake and exhaust openings and clean as required. Verify that air flows freely through the equipment. Clean the air intake and exhaust openings with compressed air or with a soft brush.

c. No further maintenance is required.

4.3 Replacement Parts

Two levels of replacement parts are available for the Topaz S3 Inverter Systems. The two levels are designated B and C. The level that you should keep on hand for your installation will vary depending on the type of maintenance planned on site, and the configuration of your Topaz S3 Inverter Systems. Having the replacement parts on hand will prevent any unacceptable delays (due to time involved obtaining spare parts) during critical periods, such as system start-up. Any items used during start-up will be replaced by MGE at no charge. Contact MGE Customer Support Services for specific recommendations. A description of each level is provided below:

Level Description

B This level of replacement parts is recommended when the user can tolerate short-duration UPS downtime to obtain replacement parts in the event of a major inverter failure.

C This level of replacement parts is recommended when the user can tolerate only a minimum of downtime in the event of a major inverter failure.

4.4 Troubleshooting and MGE Servicing

Should you encounter a problem in the operation of a Topaz S3 Inverter Systems and need MGE UPS Systems to service your product, please take into account the following recommendations.

To the extent that you feel comfortable with the unit, leave it in its current state, make a record of the display lights and messages and call either your local MGE Field Engineer or MGE's Customer Support Services at 1-800-523-0142 for assistance. Leaving the unit in its current state will enable MGE's field engineers to troubleshoot your product and bring it back on line more easily.

If you are not comfortable with the current status of the unit, you may want to take the following actions:

4.4.1 Installation Checks

Many operation problems are due to incorrect installation or setup. Before turning the unit on, review Section 2 for instructions pertaining to your particular system. Use the checklist in Table 4-1 in this review. If the system fails to operate properly after being turned on, the Table 4-1 checklist should be reverified.

Table 4-1: **Installation Checklist**

Installation Item To Be Verified	Basic Inverter System	Inverter With Static Transfer Switch
DC Input Terminals		
Voltage	☐	☐
Polarity	☐	☐
AC Input Terminals		
Voltage		☐
Connections		☐
AC Output Terminals		
Connections	☐	☐
Input Conductor Size	☐	☐
Output Conductor Size	☐	☐
Output Voltage Select	☐	☐
Frequency Select	☐	☐
Bypass Select	☐	☐
On/Off Line	☐	☐
Auto/Manual Start	☐	☐

4.4.2 Basic Inverter System (List 11, -B2 Models)

Before the inverter system can be turned on with the DC circuit breaker on the front panel, the DC power source must be energized. Upon turning the DC circuit breaker ON, a relay will energize and the cooling fan will start to operate after a short delay of less than one second. The Inverter STATUS indicator will go through a RED, YELLOW, GREEN lamp test sequence. The Bypass STATUS indicator will not be illuminated. After another short delay (less than 2 seconds) a "chirp" sound should be heard from the Inverter as the Battery Booster circuit starts up. The Inverter status indicator should turn GREEN indicating power is being supplied to the output. Using a voltmeter, verify the proper output voltage at the Receiver Cabinet terminal board, between ACOUT "L" and "N" terminals. If the Inverter STATUS indicator is YELLOW, an overload condition exists. If it is RED, the Inverter has shut down, either from a severe overload or Inverter malfunction. If the Inverter STATUS indicator should be YELLOW or RED, turn the DC circuit breaker OFF and disconnect the load wires from the ACOUT terminal block. Turn the DC circuit breaker back ON and verify the Inverter goes through its normal start-up sequence (lamp test, battery booster start-up). The Inverter STATUS indicator should be GREEN. If it is GREEN, a problem probably exists in the output load. First verify the Inverter's output voltage by using a voltmeter to check the AC output voltage on the ACOUT terminal board. Verify that a short does not exist between the Line and Neutral wires and that the load does not exceed the rating of the Inverter.

4.4.3 Inverter With Static Transfer Switch (-94 Models)

WARNING

There will be AC on the output immediately when the AC input is energized, even without turning the system ON with the DC circuit breaker. The digital LCD can display AC voltages, but not current when the DC circuit breaker is OFF since the Maintenance Bypass relay is closed.

ATTENTION

La tension de sortie AC apparaîtra de's que l'entrée AC sera sous tension, même sans que le systéme soit mis en marche par le dijoncteur DC. Le panneau de mesures digital peut afficher des tensions AC, mais pas le courant lorsque le disjoncteur DC est ouvert, vu que le realy de bypass de maintenance est fermé.

WARNUNG!

Wechselstrom ist automatisch ausgeloest wenn der Wechselstrom eingeschaltet ist ohne den Gleichstromunterbrecher anzuschalten. Der digitale LCD kann Gleichstromspannungen anzeigen, jedoch keinen Strom, wenn der Gleichstromunterbrecher OFF anzeigt, da der maintenance bypass geschlossen ist.

As soon as power is applied to the unit, either from the AC power source or the DC is applied by closing the DC circuit breaker, the unit will start up as indicated above for the basic unit. During the lamp test sequence, both STATUS indicators will go through the RED, YELLOW, GREEN lamp test sequence. STATUS indication starts to differ at this point, depending on the selected mode of operation, ON-LINE or OFF-LINE.

4.4.4 ON-LINE Mode

If AC has been applied to the Inverter and is within proper limits (120VAC or 230VAC, +/- 10% maximum) the Inverter STATUS indicator should turn YELLOW and then after a short delay, it will turn GREEN, indicating power is being supplied to the load. If the Inverter STATUS indicator remains illuminated either YELLOW or RED, follow the instructions for the basic Inverter system. The Bypass STATUS indicator will start with YELLOW and after a short delay, it will turn GREEN. If the AC input voltage is not within proper limits, the Bypass STATUS indicator will be YELLOW. If the utility AC is greatly out of limits, either too high or too low, the Bypass STATUS indicator will be RED. If it is RED, the Inverter system will not be allowed to transfer to the bypass mode in the event of an overload or Inverter failure. If the Bypass STATUS indicator is RED, the Inverter STATUS indicator will go from GREEN to YELLOW. This Bypass STATUS indicator will blink ON for one second, OFF for one second, indicating the utility AC is not the primary source powering the load.

4.4.5 OFF-LINE Mode

In this mode of operation, the Utility AC is being used to power the load. At start up, the Inverter STATUS indicator should turn GREEN after going through the lamp test sequence and power up of the battery booster. This indicator should blink ON for one second, OFF for one second, indicating it is not the primary power source for the load. The Bypass STATUS indicator should be GREEN if the utility AC is within limits, YELLOW if it is not within proper limits. If the utility AC is not within the +/- 10 % of the nominal value, the load will be powered from the Inverter.

4.4.6 Troubleshooting Guide

If installation, setup, and operation have been rechecked, use Table 4-2 to relate the symptoms to a probable cause, and obtain suggestions on how to proceed. It is not possible to anticipate all symptoms in such a guide, but those listed are the ones most frequently encountered. Therefore, the guide can help to quickly isolate most common problems.

Maximum benefit from the guide can be realized if care is taken to observe all of the information on the front panel to define complete symptoms. An in-depth knowledge of installation, setup, and operation in this manual will also greatly enhance the use of the guide.

Table 4- 2 **:Troubleshooting Checklist**

SYMPTOM	POSSIBLE CAUSE	RECOMMENDED PROCEDURE
No response when DC circuit breaker is turned ON. Inverter STATUS indicator remains non-illuminated	Polarity reversed on DC Input connections. If this is the case, the internal Soft Start fuse will need to be replaced.	Check input connections and reverse if wrong. Remove the inverter module from the receiver cabinet. The soft start fuse (F1) is located in an opening on the right hand side of the module. A spare fuse has been supplied with this manual. Replace F1 and re-install the module.
Inverter start up but STATUS indicator goes to RED after lamp test start-up load sequence.	Overload.	Connect the load directly to the AC power source and measure the current and watts.
	Incorrect Inverter output voltage or frequency.	Disconnect load. Turn system ON. Use the meter function on the front panel or multimeter to check output voltage and frequency.
	Wrong input voltage.	Check input source and system specification. If Inverter was powered up with the 230 VAC on the input and the Inverter was set for 120, damage to the Inverter module is possible. Return the unit to the depot for repair.
	Maintenance Bypass relay defective.	Turn off the DC circuit breaker on the front panel of the inverter module. Turn off the AC input circuit breaker and disconnect the AC input wires. Turn on the DC circuit breaker on the front panel of the inverter module. If the inverter STATUS indicator goes to RED, return inverter module to depot for repair. If STATUS indicator goes to GREEN, inverter is OK. Verify that no AC voltage (less than 5VAC) exist on the AC input

SYMPTOM	POSSIBLE CAUSE	RECOMMENDED PROCEDURE
		terminals and that the proper AC output voltage exist on the AC output terminal block. If 100-120 VAC or 200-240 VAC exist on the AC input terminal block, Maintenance Bypass relay is defective, replace AC EMI filter board.
Inverter will not start.	DC input voltage is too high or too low.	Measure the DC input voltage using a multimeter. Check specifications.
Inverter starts and stops. Inverter STATUS indicator illuminated RED.	Load VA is too high.	Measure load current using Utility AC power.
Inverter starts and Inverter STATUS indicator is YELLOW.	Load VA is too high.	Measure load current using Utility AC power.
Bypass STATUS indicator is YELLOW or RED.	Utility AC voltage or frequency Not in specified limits.	Check utility AC voltage with a multi-meter Check frequency to ensure it agrees with the DIP switch setting in the inverter module.

After taking these steps, make a record of the display lights and messages, call your local MGE Field Engineer or call 1-800-523-0142 for assistance.

Glossary

Symbols	
¶	Used to reference paragraph headings that are listed in the table of contents.
/	Used to represent “and/or.”
%	Percent; of each hundred.
° F.	Degrees Fahrenheit.
° C	Degrees Celsius.
@	At.
±	Plus or minus.
#	Number.
Ø	Phase.
Ω	Ohms.
2nd	Second.
AC or ac	Alternating current.
Ambient air temperature	The temperature of the surrounding air, usually defined as 23 degrees C.
Ambient noise	The noise level of the environment.
ANSI	American National Standards Institute.
Attached load	The load attached to the inverter output, such as a computer system or manufacturing system.
AWG	American Wire Gauge, formerly Brown & Sharp gauge.
Breaker	Circuit breaker.
BYPASS	See "Static Transfer Switch".
BYPASS mode	See "off-line mode".
Carrier	The company or individual responsible for delivering goods from one area to another.

C	Common.
CB	Circuit breaker.
Conduit	A flexible or rigid tube surrounding electrical conductors.
C.S.S.	Customer Support Services.
Current rating	The maximum current that a piece of electrical equipment is designed to carry.
dBA	Decibels adjusted.
dBrnC	Decibels above reference noise.
DC or dc	Direct current.
Digital Meter	The LCD display on the front panel of the inverter module.
DIP	Dual in-line package.
DPDT	Double Pole Double Throw.
Earth ground	A ground circuit that has contact with the earth.
Electrician	Refers to an installation electrician qualified to install heavy-duty electrical components in accordance with local codes and regulations. Not necessarily qualified to maintain or repair electrical or electronic equipment. Compare to technician.
MGE	MGE UPS Systems
FET	Field Effect Transistor.
FREQ	Frequency.
Frequency slew	The change in frequency per change in time. Given in terms of Hz per second (Hz/sec).
GND	Ground
Hz	Hertz, a measure of frequency; one cycle per second equals one Hertz.
Inverter mode	See "on-line mode".
I	Current.
IEC	International Electrotechnical Commission.
IEEE	Institute of Electrical and Electronic Engineers.

Input branch circuit	The input circuit from the building power panel to the equipment.
Inverter	An electrical circuit that generates an AC sinewave output from a DC input.
kVA	Kilovolt-Ampere; a measure of apparent power.
L	Line.
LCD	Liquid-crystal display.
LED	Light-emitting diode.
Mains or mains 1	Main AC input source.
Mains 2	Bypass AC input source.
mA	Milliampere.
MAX	Maximum.
MCM	Thousand circular mil; standard wire sizes for multiple stranded conductors over 4/0 AWG in diameter. M is from the Roman numeral system; it is the symbol for 1,000.
module	Refers to an inverter module.
MOV	Metal-oxide varistor.
N	Neutral.
NC	Normally closed.
NEC	National electrical code.
NFPA	National fire protection association.
NO. or No.	Part number.
NO	Normally open.
On-line mode	Inverter sources power to the output load. Inverter receives power from the DC input source.
Off-line mode	The output receives power directly from the input utility via a static transfer switch or maintenance bypass relay.
OSHA	Occupational safety and health act.
PWM	Pulse width modulator.

SCR	Silicon-controlled rectifier.
Shipping damage	Any damage done to an article while it is in transit.
SPDT	Single Pole Double Throw.
Static Transfer Switch	An electronic or solid state switching mechanism electronically controlled to pass AC power directly from the utility to an output load.
Technician	Refers to an electronic technician qualified to maintain and repair electronic equipment. Not necessarily qualified to install electrical wiring. Compare with electrician.
Test connector	DB-9 type connector on the rear panel allowing an MGE Customer Support Services technician to access programmable and diagnostic features of the system.
VA	Volt-amps: Apparent power in volts X amperes.
VAC	Volts of alternating current.
VDC	Volts of direct current.
Watts	Real power - joules/second

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